

### REMARKS/ARGUMENTS

Favorable reconsideration of this application, as presently amended and in view of the following discussion, is respectfully requested.

After entry of the present amendment, Claims 1-13 are pending; Claims 1-10 are presently active, and Claims 11-13 are withdrawn without prejudice or disclaimer. The present amendment amends Claims 1 and 7 without introduction of new matter.

In the outstanding Office Action, Claims 1, 2, 5, and 7-10 were rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent No. 6,251,781 to Zhou et al. (hereinafter “Zhou”) in view of U.S. Published Application No. 2002-0025675 to Chu. That rejection is respectfully traversed.

Though they are different in scope, each of amended independent Claims 1 and 7 recite structure or steps, respectively, providing: (1) a via plug electrically connecting two interconnect layers and composed of a single crystal material; and (2) a second interconnect layer in an interconnect trench having a bottom connected to a connection hole and composed of a polycrystalline material. The remaining pending claims depend from Claims 1 and 7.

By way of background, the present invention addresses a semiconductor fabrication problem illustrated in Applicants’ Figures 16 and 17. More particularly, as shown in Figure 16, where copper is buried in a via hole 102 using a chemical vapor deposition method, a sputtering method, or the like, the copper may form unstable grain boundaries 103.<sup>1</sup> If the semiconductor device is heated, the unstable crystal grains may migrate and thereby leave a void 104.<sup>2</sup>

Applicants’ Figures 6, 12, and 15 illustrate a non-limiting examples of (1) a via plug electrically connecting two interconnect layers and composed of a single crystal material; and (2) a second interconnect layer in an interconnect trench having a bottom connected to a

---

<sup>1</sup> Applicants’ specification, page 1, line 24, to page 2, line 10.

<sup>2</sup> Applicants’ specification, page 2, lines 13-23.

connection hole and composed of a polycrystalline material. As shown in Figure 6, a single crystal material is formed in the via hole 22, but a polycrystalline material is formed in the interconnect trench 23.

The outstanding Office Action cites Zhou's Figure 9 as teaching the configuration of the claimed invention, as modified in view of Chu to include a single-crystal of copper filling within Zhou's connection hole. Regarding the modification, the Action further states that it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the via plugs of Zhou with a single crystal structure, as taught by Chu, in order to simplify the manufacturing process, and to make the thickness of the barrier layer in Zhou 1 nm thick as taught by Chu to thereby meet the thickness requirements sought current for IC technology.<sup>3</sup>

Figure 9 of Zhou shows the copper layer 80 as buried in both the via hole and an overlying interconnect trench. However, Zhou does not disclose whether the copper layer 80 is a single crystal or a polycrystal. Thus, as Zhou does not address crystal structure, the reference clearly cannot teach the copper layer 80 as having both a single crystal and polycrystalline structure within the via hole and overlying trench, respectively.

Chu discloses via plugs composed of single crystal metals. However, Chu also fails to disclose a copper layer having both a single crystal and polycrystalline structure within a via hole and overlying trench, respectively. If Zhou is modified in view of Chu (in the manner proposed by the Office Action), there is no suggestion that the modification would result in Zhou's copper layer 80 having both a single crystal and polycrystalline structure within the via hole and overlying trench, respectively. Furthermore, Applicants note the Office Action does not provide citation of text for the teachings relied upon in support of the asserted motivation.

---

<sup>3</sup> Office Action, 6/6/2005, page 3.

Accordingly, for the above-stated reasons, Applicants respectfully request that the rejection of Claims 1, 2, 5 and 7-10 under 35 U.S.C. § 103(a) as unpatentable over Zhou in view of Chu be withdrawn.

Regarding Claim 5, Applicants again note that Zhou does not address crystal structure. Thus, Zhou cannot teach the crystal orientation of the copper layer 80 of the connection hole as being the same as the crystal orientation of the conductive traces 58. Further, the Office Action does not explain how the asserted modification of Zhou in view of Chu would produce such a similarity in crystal orientation. Accordingly, Applicants respectfully submit the Office Action does not establish Zhou, as modified, as teaching the claimed feature of "the copper of the connection plug has the same crystal orientation as that in a part of the first interconnect layer which is located immediately below and close to the connection hole in the first interconnect layer".

Consequently, in view of the present amendment and the preceding discussion, the present application is believed to be in condition for allowance. An early and favorable action to that effect is respectfully requested.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
MAIER & NEUSTADT, P.C.



Eckhard H. Kuesters  
Attorney of Record  
Registration No. 28,870

Customer Number  
**22850**

Tel: (703) 413-3000  
Fax: (703) 413-2220  
(OSMMN 06/04)

\\ATTYS0124\S0248232US\248232US-AM.DOC